United States
Environmental Protection
Agency

Office of
Air and Radiation
Washington, DC 20460

EPA

OMS
Advisory Circular

SUBJECT: Assigned Deterioration Factors for 1988 Model Year Light-Duty Vehicles, Light-Duty Trucks, and Heavy-Duty Engines

I. Purpose

This advisory circular (A/C) updates previously provided deterioration factors (DF's) and adds a new DF in response to changes in the regulations.

This A/C supersedes A/C Nos. 51B and 51B-1 beginning with the 1988 model year.

II. Background

A. 1. Section 206(a)(1) of the Clean Air Act (CAA) requires the Administrator to apply "adjustment factors" for those manufacturers selling fewer than 300 vehicles or engines in lieu of requiring durability testing beyond 5,000 miles. These adjustment factors are to be appropriate to assure that each vehicle or engine will comply, during its useful life, with emission standards. Guidance as to how to receive such adjustment factors is supplied in this A/C.

2. EPA, under its implicit authority, has extended the definition of small-volume manufacturers to include total sales up to 10,000 units. In addition, the use of assigned DF's was extended to large-volume manufacturers having an engine family, or families, with total sales of 10,000 units or less. However, the requirement of the CAA that adjustment factors (i.e., assigned DF's) be appropriate to assure compliance with standards over the useful life still applies. EPA has historically determined appropriate assigned DF's by deriving such factors from data generated on vehicles and engines actually run through the full durability program. Hence, these DF's could only reasonably assure compliance if applied to vehicles using emission control systems of technology type, design characteristics, and quality comparable to that of systems subjected to full durability testing. This, historically, has been the usual case. Manufacturers certifying with assigned DF's have tended to use emission control systems which have been certified in other applications

under full durability vehicle evaluation or have been comparably designed and constructed to have similar durability. However, we are now aware that some manufacturers have made application for certification using emission critical components which have not been tested for durability or may not have been comparably designed and constructed. This A/C is being revised to reaffirm that the assigned DF's contained within can reasonably assure compliance with emission standards over the useful lives of vehicles only if applied to emission control systems comparable to those from which the assigned DF's were derived. This A/C provides guidance on how a manufacturer can reasonably demonstrate that its emission control system is sufficiently comparable to an effective and proven system for which the assigned DF's provided herein can be judged appropriate.

B. A review of available certification data, independently supported by in-use data, indicate evaporative system deterioration is typically higher than the assigned DF value for light-duty vehicles (LDV's) and light-duty trucks (LDT's) depicted in A/C No. 51B. As a result EPA has updated the assigned DF value for evaporative systems for LDV's and LDT's.

C. In the final rulemaking action published on March 15, 1985, particulate standards were established for heavy-duty diesel engines. This A/C provides an assigned DF for this emission component.

D. Historically EPA has required that when a manufacturer chose to use the assigned DF values provided by EPA, these assigned DF's were to be used for each emission standard applicable for the vehicle/engine. In this A/C, EPA will allow a manufacturer to separate the idle CO DF, evaporative DF, and smoke DF's from the exhaust emission DF's. See paragraph XI.C.

E. A draft copy of this A/C was provided to the regulated industry via an August 22, 1986 correspondence requesting comments on this A/C. Four responses were received primarily expressing concern over the effective model year for the revised light-duty evaporative emission DF value. This A/C was revised to respond to these concerns. The remaining comments are addressed in a separate summary letter.

F. In reviewing the categories for which DF's have been published, the decision was made to eliminate several categories as these engine-system categories are no longer being certified. The categories eliminated are, "non-catalyst-equipped" for LDV's and LDT's, and "oxidation-catalyst equipped" for LDV's.

G. In the final rulemaking action published on November 16, 1983, the definition for useful life for light-duty trucks and heavy-duty engines was set forth. This A/C updates the applicable DF's by inserting the applicable useful life mileage value in the equations.

H. For cases where a new or innovative technology is applied, it will be necessary to develop appropriate DF's on a case-by-case basis. This A/C provides only very general guidelines as it is not possible to develop more details without having a specific proposed control system to evaluate.

I. Finally, this A/C describes a few situations where EPA would likely conclude that the proposed vehicle designs are likely to substantially fail emission standards well before reaching their useful life in use. In these cases, EPA will work with the manufacturer to resolve our durability concerns and determine an appropriate assigned DF on a case-by-case basis.

III. Applicability

With the exception of the light-duty vehicle evaporative DF value depicted in Attachment I, this A/C is effective for 1988 model year light-duty vehicles, light-duty trucks and heavy-duty engines. The light-duty vehicle evaporative value to be used for the 1988 model year will be 0.0. Beginning in the 1989 model year, the evaporative DF will be 0.4 as depicted in Attachment I.

IV. Discussion

A. The assigned DF's contained in this A/C were derived as follows:

1. Light-Duty Vehicles:

a. Except as noted below, all light-duty DF values reflect the appropriate 70th percentile of the data base population.

b. 1. As a result of in-use data collected, it is clear the evaporative control systems currently used typically on LDV's and LDT's have emission levels significantly above the current standard. These in-use data indicate the assigned DF value of 0.0, depicted in A/C No. 51B, understates evaporative system deterioration.

2. Historically EPA has derived the assigned DF values on the basis of actual durability data. In the case of the new evaporative DF this could not be done as there is no "standard" durability test procedure. To provide the same basic level of compliance stringency the following procedure was used to arrive at the new assigned DF value of 0.4 for evaporative systems. The 4,000-mile evaporative compliance values were subtracted from the standard (2.0 grams per test). The emission level at which 90 percent of the vehicles were at or below was then determined (at a 90 percent confidence level). This value, 1.6, was subtracted from the standard to arrive at 0.4 as the new assigned DF value. This new DF will require the small-volume manufacturer to comply at the same basic level of stringency as the current level for large-volume manufacturers.

c. Light-Duty Truck Idle CO Value: The DF value is based on the value depicted in A/C No. 51B-1 and is adjusted to reflect the applicable useful life category.

2. Heavy-Duty Gasoline Fueled Engines:

a. Non-Catalyst DF Values: These values are based on the DF values depicted in A/C No. 51B adjusted to reflect the applicable useful life categories.

b. Oxidation Catalyst DF Values: These values are based on a mathematical model. This approach calculates heavy-duty factors based on light-duty data. The approach takes into account higher lead, phosphorus, and heat loadings that would be experienced by heavy-duty vehicles as well as greater catalyst volume and more active "sites." This approach is described in the December 1979 Summary and Analysis of Comments to the NPRM: "1983 and Later Model Year Heavy-Duty Engines," pp 137 and following.

3. Heavy-Duty Diesel Engines:

a. The heavy-duty diesel DF's are based on the additive DF values contained in A/C No. 51B adjusted to reflect the useful life categories.

b. Particulate Value: There are no existing certification data from which to derive a particulate DF. However, EPA did describe expected DF's in a draft Regulatory Impact Analysis. The data received during the comment period to the rulemaking action projected DF's equal to or greater than the DF's expected by EPA. In these documents EPA estimated the DF for heavy-duty diesel engines to range from 1.15 to 1.22. EPA has chosen to use the 1.22 value as the base DF. As additional data become available, EPA will review the

appropriateness of the value as we have for each value in the past. At this time, however, there are insufficient data to derive separate DF values for each of the three useful life mileage intervals. Thus, the 1.22 value was then increased by a 15 percent safety factor consistent with the approach used for other exhaust emission DF's.

c. Additive HC, CO, and NOx: The HC, CO, and NOx assigned DF's were made available in a correspondence dated March 6, 1984. These values reflected a useful life of 200,000 miles. In this A/C the March 6, 1984 values have been adjusted to reflect the three useful life categories.

B. A new paragraph entitled "General Guidelines on the Use of Deterioration Factors" has been added. These guidelines reflect current intent and do not reflect an increase in stringency in the use and approval of assigned DF's. They have been added to provide guidance to a number of small-volume and other manufacturers that have just recently initiated, or are contemplating initiating the certification process for the first time and are planning on relying upon assigned DF's.

V. Eligibility

A. To use assigned DF's, one of the three following conditions must be met:

1. The manufacturer elects to use assigned DF's under small-volume manufacturer procedures described in §86.084-14; or

2. The manufacturer has been approved by the Administrator to use the small-volume engine family assigned DF's (ref: §86.085-24(e)(2)); or

3. The manufacturer has total projected sales of less than 2,000 units in a given model year in any of the following classes:

   a. 2,000 gasoline-fueled light-duty vehicles, or

   b. 2,000 diesel light-duty vehicles, or

   c. 2,000 gasoline-fueled light-duty trucks, or

   d. 2,000 diesel light-duty trucks, or

   e. 2,000 gasoline-fueled heavy-duty engines, or

   f. 2,000 diesel heavy-duty engines.

The manufacturer may elect to use DF's depicted in this A/C only for engine families which fall into these qualified classes (ref: §86.085-24(e)(1)).

B. A manufacturer may claim a 10,000 unit exemption under the provision of §86.084-14(b)(1) (small-volume manufacturer) or §86.085-24(e)(2) (small-volume engine families) but not under both provisions concurrently.

C. The 10,000 unit exemption allowed under the provisions of §86.084-14(b)(1) (small-volume manufacturer) or §86.085-24(e)(2) (small-volume engine families) takes into consideration any exemption allowed under the provisions of §86.085-24(e)(2). For example, if 2,000 gasoline-fueled heavy-duty engines and 2,000 diesel heavy-duty engines are exempted under the provisions of §86.085-24(e)(1), only 6,000 light-duty vehicles and/or trucks can be exempted under the provisions of §86.084-14 or §86.085-24(e)(2).

D. For a manufacturer to comply with the small-volume manufacturer certification procedures, the total U.S. sales (see paragraph IX) for the model year in which certification is sought must be fewer than 10,000 units (LDV's, LDT's, and HDE's combined).

E. When assigned DF's are used under the small-volume family provisions of §86.085-24(e)(2), the manufacturer determines how the 10,000-unit limitation is apportioned to the various classifications of vehicles, trucks, and engines. For example, one (or more) vehicle family with sales of 5,000-units, one (or more) truck family with sales of 4,000-units and, one (or more) engine family with sales of 1,000-units for a total of 10,000 units.

VI. General Guidelines on the Use of the Deterioration Factors in this A/C

A. When a manufacturer demonstrates to the satisfaction of the Administrator that the control system technology described in its application is comparable to an effective and proven system technology which has successfully been demonstrated elsewhere under a full certification durability program, the applicable DF's depicted in Attachment I may be used. The affirmation to establish the suitability of the DF's for a particular engine/emission control system may take anyone (or any combination) of the acceptable forms described below.

B. For those manufacturers who cannot confirm or demonstrate the durability criteria described below, or manufacturers selling fewer than 300 total vehicles or engines and who do not wish to confirm or demonstrate the appropriateness of the assigned deterioration factors using the durability criteria described below, EPA will work with these manufacturers to determine appropriate DF's on a case-by-case basis.

Manufacturers must provide:

1. Confirmation that the engine/emission control system in question is essentially identical to, or would qualify under the guidelines of A/C No. 17F for durability carryover from, a system which has satisfactorily completed durability testing.

2. Confirmation that all emission related components have successfully completed full durability testing evaluation over the regulated useful life in some other certified engine family. In addition, the manufacturer must also demonstrate that applicable components will be employed in an operating environment (temperature, maximum flow, etc.) similar to the originally "certified" case.

3. Demonstration that all emission related components are of comparable functional quality and manufactured using similar production materials and techniques as components which have been demonstrated in some other certified engine family which, in turn, was certified with a full durability test over the regulated useful life. In this case, the manufacturer must demonstrate that all components have been applied in an operating environment similar to the comparable part in the originally certified engine family.

4. Demonstration that all emission related components have a similar durability performance capability, based upon durability data provided by the supplier of the component, as components which have been demonstrated in some other certified engine family which, in turn, was certified with a full durability test over the regulated useful life. In this case, the manufacturer must demonstrate that all components have been applied in an operating environment similar to the comparable part in the originally certified engine family.

C. In all cases above, all fittings, conduits, hoses, and fasteners must be of state-of-the-art automotive technology designed to fulfill their intended function over the useful life of the vehicle in the environment expected in their intended application.

VII. Determination of Appropriate DF for New or Innovative Technology which Differs Significantly from the State-of-the-Art Technology

A. Once a new technology has successfully completed full durability testing over the regulated useful life, EPA will derive assigned DF's based upon the certification data from such systems. In the event new technology is being forced as a result of new emission standards (as is the case of particulate traps), EPA will initially develop DF's from the technology assessment data and relevant comments considered in the regulatory development process.

B. In cases where a manufacturer applies a new technology that has not been demonstrated in any comparable form through full certification, the manufacturer will need to provide development data, including bench test data or other durability data which do not necessarily involve the testing of complete vehicles or engines and an analysis of the expected deterioration of the system in the application environment. The manufacturer shall propose appropriate DF's (which may not be lower than the lowest assigned DF's in this A/C for the engine/vehicle category involved). EPA's review and ultimate determination of the appropriate DF's in such instances will have to be handled on a case-by-case basis. More specific criteria cannot be specified in advance without knowing what new innovations might arise.

VIII. Cases where EPA is Likely to Conclude an Emission Control System is Non-Durable

Vehicles employing an emission control system EPA would likely conclude as being non-durable, as set forth in the criteria below, may not use the DF values depicted in this A/C. In those cases where a system is classified as non-durable, EPA will work with the manufacturer to resolve durability concerns and then determine appropriate DF's on a case-by-case basis. Examples of a non-durable emission control system are as follows:

A. A vehicle emission control system will be considered non-durable if the catalyst operating temperature environment of the vehicle substantially exceeds the catalyst operating temperature environment of a comparable durability vehicle from an engine family that has been certified. (The temperature criteria of A/C No. 17F can be used for additional guidance on acceptable catalyst temperature criteria.) EPA, in particular, will scrutinize designs with catalysts installed abnormally

close to the exhaust manifold as these designs tend to be very efficient at low mileage but have high deterioration rates due to thermal degradation.

B. A vehicle emission control system will be considered non-durable if the exhaust gas oxygen sensor is located in a position prone to damage from moving suspension parts, road debris (rocks), water splash from tires, etc.

C. 1. A vehicle emission control system will be considered non-durable when aftermarket catalytic converters not designed for full useful life operation are used.

2. A reasonable basis must be provided to conclude that an aftermarket converter is likely to perform satisfactorily over the full useful life. New aftermarket catalytic converters which exhibit a conversion efficiency below 90 percent for HC, or below 90 percent for CO, or below 60 percent for NOx will be classified as non-durable. This efficiency is based on 25,000 miles durability testing measured in accordance with an EPA approved procedure.

D. A vehicle emission control system will be considered non-durable if the catalyst size, surface area, and noble metal loading are abnormally low compared to catalysts used in comparable certified designs.

E. A vehicle emission control system will be considered non-durable if low quality construction materials or poor construction techniques are used. For example, we would question the use of mild copper tubing when stainless steel is the industry norm.

IX. U.S. Sales Volume Determination

A. Small-Volume Manufacturer

1. Production from facilities leased, operated, controlled, supervised, or which are ten percent (or greater) owned by the manufacturer shall be counted in the calculation of total U.S. sales (ref: §86.085-1(e)).

2. In addition, where there is more than one importer or distributor of vehicles and/or engines manufactured by the same entity the aggregate sales (projected or actual) by all of the importers and distributors are to be used (ref: §86.084-14(b)(2)).

3. Paragraphs 1 and 2 of this section are restating the language contained in paragraph IV.B of A/C No. 51B. The above language will not be the basis for aggregating sales between independent importers.

B. Small-Volume Engine Families

1. Single manufacturer: To be eligible for the use of assigned DF's, the total U.S. sales of a single engine family or any combination of engine families may not exceed 10,000 units.

2. Multiple manufacturers: If one (or more) manufacturer is owned by a holding company, or a single manufacturer has 50 percent or more ownership in another company, then the U.S. sales of each entity will be counted to determine the aggregate sales of small-volume engine families. For example, a holding company may own two manufacturing entities. If one manufacturer has requested DF's for engine families with total sales of 7,000-units the second manufacturer can request DF's for any combination of family sales less than 3,000 units.

3. If there are any disputes as to which of these entities is entitled to what portion of the allotted 10,000 sales, EPA will not act as a referee and will make total sales determination on a first-come first-serve basis.

X. Deterioration Factors

When an eligible manufacturer elects to use assigned DF's, in accordance with the criteria of Sections VI, VII, and VIII the values to be used are found in Attachment I to this A/C.

XI. Other Provisions

A. An eligible manufacturer who chooses to use assigned DF's outlined in this A/C must make a request in writing to:

Chief, Certification Branch
U.S. Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, Michigan 48105

Each request should state which of the eligibility criteria are applicable and the applicable projected sales.

B. To facilitate data processing, it will be necessary to put the correct data sheet "code" in the appropriate field. Attachment II depicts the proper codes.

C. 1. The provisions of §86.087-23(b) allow manufacturers of light-duty vehicles (evaporative DF only), light-duty trucks, and heavy-duty engines to determine specific emission deterioration using good engineering practice. This A/C also provides DF values for all of the above cases. If a manufacturer believes the DF values contained in this A/C are inappropriate for its emission control system they may chose to certify using self-determined DF's in accordance with the applicable provisions in §86.087-23(b).

2. The durability procedures for determining the light-duty evaporative level, the light-duty truck idle CO level, the heavy-duty diesel smoke levels, and the exhaust emission levels are independent from each other. For this reason, the eligible manufacturer may use assigned DF values for some of these independent durability procedures and generate DF values for the other independent durability procedures.

3. A manufacturer may NOT use DF's from this A/C for some, but not all, emission standards encompassed by a single durability procedure. For example, a manufacturer could not use the assigned DF's provided in this A/C for HC and NOx and then request the use of a CO DF generated via a durability schedule.

4. The compliance methodology chosen by the eligible manufacturer in XI.C.2 must be applied uniformly across the product line.

D. Use of assigned DF's does not relieve the manufacturer of any responsibility to comply with other motor vehicle emission control requirements, including the requirements for testing of emission-data vehicle(s), recommending reasonable maintenance to the ultimate purchaser, warranting of emission control systems, labeling, et cetera.

E. If a manufacturer is using an engine system control(s) that has not been assigned a specific set of DF values, the manufacturer is to contact its Certification Division representative for guidance.

Richard D. Wilson
Director, Office of Mobile Sources

Attachments

ATTACHMENT I

ASSIGNED DETERIORATION FACTORS

I. For Light-Duty Vehicles

Type of Engine	Deterioration Factors HC	CO	NOx	Evap	Particulate
A. Gasoline-Fueled Catalyst-Equipped	1.3	1.2	1.1	0.4*	N/A
B. Diesel Engines	1.0	1.2	1.0	N/A	1.5

* For the 1988 model year ONLY the value of 0.0 may be used as an assigned DF for the evaporative HC emission level.

NOTE: The HC, CO, NOx, and particulate deterioration factors are multiplicative. Evaporative deterioration factors are additive.

II. For Light-Duty Trucks

Type of Engine	Deterioration Factors HC	CO	NOx	Evap	Particulate
A. Gasoline-Fueled Oxidation Catalyst-Equipped	1.7	1.5	1.0	0.4*	N/A
B. Gasoline-Fueled Three-Way Catalyst-Equipped	1.7	1.5	1.2	0.4*	N/A
	Idle CO = 2.1				
C. Diesel Engines	1.0	1.2	1.0	N/A	1.5

* For the 1988 model year ONLY the value of 0.0 may be used as an assigned DF for the evaporative HC emission level.

NOTE: The HC, CO, NOx, particulate, and idle CO deterioration factors are multiplicative. Evaporative deterioration factors are additive.

Attachment I
(continued)

III. For Heavy-Duty Gasoline-Fueled Engines:

Type of Engine	Deterioration Factors HC	CO	NOx	Idle CO
A. Gasoline-Fueled Non-Catalyst-Equipped	0.07	6.53	0.66	2.04
(ADDITIVE)				
B. Gasoline-Fueled Catalyst-Equipped	1.88	1.56	1.24	2.04*
(MULTIPLICATIVE -- except *)				

NOTE: Idle CO is additive in both categories.

Attachment I
(continued)

IV. For Heavy-Duty Diesel Engines:

A. Diesel; Without After-Treatment

	Deterioration Factors						
	Gaseous				Smoke		
Useful Life	HC	CO	NOx	Particulate	A	B	C
110,000-miles	0.1	0.4	0.4	0.04	1.10	1.60	0.89
185,000-miles	0.1	0.7	0.4	0.04	1.88	2.73	1.53
290,000-miles	0.2	1.1	0.7	0.04	2.97	4.32	2.41

NOTE: All of the above DF's are additive.

B. Diesel; With After-Treatment

	Gaseous				Smoke		
Useful Life	HC	CO	NOx	Particulate	A	B	C
110,000-miles	1.3	1.3	1.2	1.37	1.10	1.60	0.89
185,000-miles	1.3	1.4	1.2	1.37	1.88	2.73	1.53
290,000-miles	1.5	1.6	1.3	1.37	2.97	4.32	2.41

NOTE: The HC, CO, NOx, and particulate deterioration factors are multiplicative. Smoke deterioration factors are additive.

A = Acceleration Smoke, B = Peak Smoke, and C = Lug Smoke

ATTACHMENT II

DATA ENTRY CODES

I. For Light-Duty Vehicles

Type of Engine	Data Code
Gasoline-Fueled Catalyst-Equipped	3
Diesel Engines	4

II. For Light-Duty Trucks

Type of Engine	Data Code
Gasoline Fueled Oxidation Catalyst-Equipped	1
Gasoline Fueled Three-Way Catalyst-Equipped	3
Diesel Engines	4

The above data entry codes are applicable to the "Vehicle Information Data Sheet" (VI) and the "Summary Sheet Input Form" (SS). The applicable data code, depicted above, is to be entered in the "assigned DF" field on the VI data sheet; card 5, column 21 and 40. Likewise, the applicable data code is to be entered in the "Durability Vehicle ID" field on the SS input form; card 2, column 1.

For vehicle information carried over where assigned DF's were used, the applicable data entry code, depicted above, must be entered.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR AND RADIATION

February 26, 1987

CD-87-02 (LD/HD)

Dear Interested Parties:

Subject: Assigned Deterioration Factor Addendum

Mercedes-Benz of North America has identified an error in the light-duty vehicle diesel particulate value. The value should be 1.2. In addition, Caterpiller Tractor Co. has pointed out that the convention of identifying the lug smoke value as "B" and the peak smoke value as "C" had been reversed in A/C No. 51C. This addendum to A/C No. 51C corrects both of these oversights.

If you have any questions regarding this correspondence, please contact Mr. Clifford D. Tyree at 313-668-4310.

Sincerely yours,

Robert E. Maxwell, Director
Certification Division
Office of Mobile Sources

Enclosure

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A/C No. 51C Addendum

ATTACHMENT I

ASSIGNED DETERIORATION FACTORS

I. For Light-Duty Vehicles

	Type of Engine	Deterioration Factors HC	CO	NOx	Evap	Particulate
1.	Gasoline-Fueled Catalyst-Equipped	1.3	1.2	1.1	0.4*	N/A
2.	Diesel Engines	1.0	1.2	1.0	N/A	1.2

* For the 1988 model year ONLY the value of 0.0 may be used as an assigned DF for the evaporative HC emission level.

NOTE: The HC, CO, NOx, and particulate deterioration factors are multiplicative. Evaporative deterioration factors are additive.

II. For Light-Duty Trucks

	Type of Engine	Deterioration Factors HC	CO	NOx	Evap	Particulate
1.	Gasoline-Fueled Oxidation Catalyst-Equipped	1.7	1.5	1.0	0.4*	N/A
2.	Gasoline-Fueled Three-Way Catalyst-Equipped	1.7	1.5	1.2	0.4*	N/A
	Idle CO = 2.1					
3.	Diesel Engines	1.0	1.2	1.0	N/A	1.5

* For the 1988 model year ONLY the value of 0.0 may be used as an assigned DF for the evaporative HC emission level.

NOTE: The HC, CO, NOx, particulate, and idle CO deterioration factors are multiplicative. Evaporative deterioration factors are additive.

Revised:

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A/C No. 51C Addendum

Attachment I
(continued)

IV. For Heavy-Duty Diesel Engines:

Type of Engine	Deterioration Factors HC	CO	NOx	Particulate	A	B	C
1. Diesel; Without After-Treatment							
110,000-miles	0.1	0.4	0.4	0.04	1.10	0.89	1.60
185,000-miles	0.1	0.7	0.4	0.04	1.88	1.53	2.73
290,000-miles	0.2	1.1	0.7	0.04	2.97	2.41	4.32

NOTE: All of the above DFs are additive.

2. Diesel; With After-Treatment							
110,000-miles	1.3	1.3	1.2	1.37	1.10	0.89	1.60
185,000-miles	1.3	1.4	1.2	1.37	1.88	1.53	2.73
290,000-miles	1.5	1.6	1.3	1.37	2.97	2.41	4.32

A = Acceleration Smoke, B = Lug Smoke, and C = Peak Smoke

NOTE: The HC, CO, NOx, and particulate deterioration factors are multiplicative. Smoke deterioration factors are additive.

Revised: 2/26/87

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A/C No. 51C Addendum

Attachment I
(continued)

III. For Heavy-Duty Gasoline-Fueled Engines:

Type of Engine	Deterioration Factors HC	CO	NOx	Idle CO
1. Gasoline-Fueled Non-Catalyst-Equipped	0.07	6.53	0.66	2.04
(ADDITIVE)				
2. Gasoline-Fueled Catalyst-Equipped	1.88.	1.56	1.24	2.04*
(MULTIPLICATIVE -- except *)				

NOTE: Idle CO is additive in both categories.

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